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*SUPERPOSED OR DUPLICATED SPECTRUM FRINGES**

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1. *Introductory.*—To obtain sharp spectrum fringes it is necessary, as a rule, to use a slit narrow enough to show the Fraunhofer lines. Hence there is sometimes a deficiency of light from this reason alone. It occurred to me on producing identical fringes of inclination (achromatics or monochromatics) and of color (dispersion), that by their superposition a slit of any width (or an entire absence of slit) would be admissible, without destroying the fringes in the impure spectrum resulting.

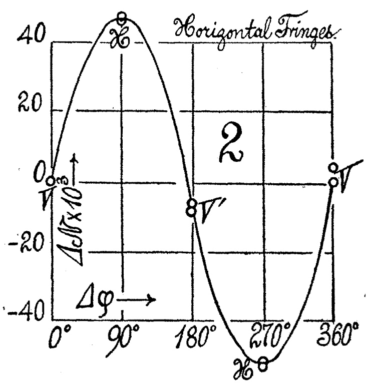
Furthermore if the edge of the prism is rotated around the axis of the spectro-telescope 180°, the inclination of all spectrum fringes must be symmetrically reversed; i.e., inclination up toward the right (positive) will become inclination down on the right (negative) to the same amount. The identical result may also be reached independently by displacing one of the mirrors of the interferometer parallel to itself (path difference) until the fringes passing through their maximum size reach the opposed inclination and size. Hence there must be a relation of a periodic kind between the displacement of mirror (ΔN) and rotation of the spectro-telescope ($\Delta\varphi$), by which sharpness of fringes in the absence of a slit is conditioned.

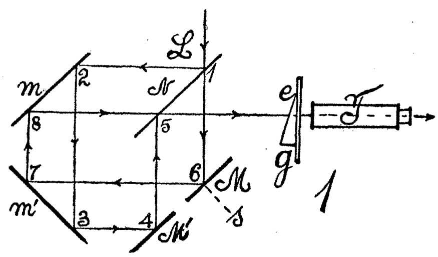
This device of locating an angle of rotation of the telescope by sharpness of fringes, may possibly be used for other purposes something after the manner of the halfshade or the sensitive tint; for if small, they jump suddenly out of an intensely brilliant unbroken spectrum band, when a definite $\Delta\varphi$ is reached.

Finally, as the fringes are examples of interference of intense non-reversed spectra, they should be available in such experiments as described in my last paper, for instance.

*Advance account, from a Report to the Carnegie Institution of Washington.

2. *Apparatus.*—To fix the ideas it will be necessary to give a diagram of the apparatus (fig. 1) employed. It is the selfadjusting interferometer, very serviceable here because of the large number of separate adjustments to be made, each of which might otherwise require long searching for fringes. White light L from a collimator takes the paths $12345T$ and $16785T$, N being a halfsilver. The telescope T is provided with the direct vision grating g, capable of rotating around the axis $5T$ (angle $\Delta\varphi$). T and g are preferably rotated together, as a rigid system. The mirror MM' consists of two independent, nearly coplanar parts, as shown, one of which, M for instance, may be displaced parallel to itself by the micrometer screw along the normal s (displacement ΔN). Path difference to the amount $2 \Delta N \cos 45°$ is thus introduced more than sufficient to pass the spectrum fringes through their maximum sizes between extremes of hair lines. By rotating m on a horizontal axis and m and M' on vertical axes, fringes of all sizes and inclinations when at their maximum may be obtained. The character of the





fringes due to inclination is shown by the achromatics and hence the adjustment is made with reference to them. They depart but little, relatively speaking, from their slope throughout the experiment.

3. *Observations.*—For the present purposes, the case of achromatic fringes, horizontal, vertical, and at about 45°, respectively, will suffice. Moreover, relatively small fringes, requiring much larger displacements (ΔN) than very large fringes, will generally be preferable.

Figure 2 gives an example of the results for horizontal achromatic or monochromatic fringes, the ordinates showing the displacement of micrometer ΔN (at M fig. 1) in 10^{-3} cm., and the abscissas the corresponding rotation of spectro-telescope (gT, fig. 1), needed to produce sharp fringes in the spectrum of an indefinitely wide slit. When the fringes are small, a few degrees of excessive rotation $\Delta\varphi$, either way, will cause them to vanish completely, so that the orientation for sharp fringes is quite sensitive. The symbols H (horizontal) and V (vertical) refer to the orientation of the edge of the prism, or the lines of the grating. The plane of dispersion is thus normal to H and V.

Hence it appears that horizontal fringes are left unchanged when the plane of dispersion is horizontal (edge of prism vertical), which is to be expected; for in such a case the light is permanently absent at the absorption bands due to the inclination fringes. On the other hand when the plane of dispersion is vertical, the nearly horizontal fringes have to pass from the positive to the negative inclination through their maximum size, when the telescope is rotated over 180°, and hence ΔN is very large, particularly so when the fringes are relatively small. In this large displacement of mirror (ΔN = .10 cm., nearly) small monochromatic fringes will not change their inclination much; but their size will change considerably, and thus at $\Delta\varphi = 90°$ they are large and at $\Delta\varphi = 270°$, small.

Exactly the opposite conditions are met with when the fringes are nearly vertical, and the data may be omitted here. In figure 2, V' lies somewhat below V, as I could not (for incidental reasons) obtain adequately horizontal fringes without extreme difficulty. But this amounts merely to a slight shift of phase in the diagram. The vertical fringes were larger and hence a smaller double amplitude of displacement (ΔN = .07 cm.) was here recorded.

Finally in the results for achromatic fringes at about 45° (estimated by the eye) the maxima were somewhere near $\Delta\varphi = 45°$ and 135°. Though the results were less smooth here, from deficiencies in the orientation (45°) of the achromatics, there was no fault to be found with the clearness of fringes, or with their abrupt evanescence.

If the spectrotelescope Tg (fig. 1) with a very fine slit is rotated, the fringes remain parallel to the length of the spectrum passing through a symmetrical case where the spectrum is reduced to a single fine colored line parallel to the slit. The fringes remain nearly parallel to the edge of the prism. Hence if any form coincides with the achromatic or monochromatic fringes, it will be retained on opening the slit wide, whereas the other forms, inasmuch as they require a fine slit, will vanish with the Fraunhofer lines. In the absence of a slit, the whole colored field bursts into sharp fringes, whenever the proper angle $\Delta\varphi$ of the telescope is reached. If the slit is a little too broad to show the solar lines distinctly, the monochromatic fringes may often be detected crosshatching the vague Fraunhofer lines, even when the spectrum fringes are still strong.

If the fringes of a fine slit are at say 45° to the axis, their inclination will change to 135° on passing the symmetrical stage; but there is apt to be both a change of size and angle in such cases.

Summary.—It has been shown in the experiments that the fringes (monochromatic) due to differences of inclination of rays, and the fringes (dispersion) resulting from differences in wave length of rays may be made of nearly equal size by displacing any mirror of the rectangular interferometer normal to itself (ΔN). The fringes will not, however, generally have the same inclination. This may be imparted to the spectrum fringes by rotating the spec-

tro-telescope (prism edge) on its axis until the inclinations also coincide. In reality the phenomenon is more complicated as the spectrum fringes change both size and inclination on rotation of the spectrum. In case of the completion of this twofold adjustment the slit of the collimator may be made indefinitely wide or removed altogether (undesirable light is to be screened off). The spectrum fringes may thus be given any intensity of illumination at pleasure, while the wave length corresponding to any fringe may be found by narrowing the slit until the Fraunhofer lines reappear. When the fringes are small the orientation of the spectro-telescope revolving around its axis may be determined by the appearance and evanescence of fringes. On the other hand the spectro-fringes, particularly if large, remain clearly enough in the field for the observation of the motion of a large number (i.e., for interferometry), before they vanish.

Similar results were obtained in broadening the vertical string of interference beads of reversed spectra. An account of these experiments will have to be omitted here, as they are much more complicated.

AN ELECTROMAGNETIC HYPOTHESIS OF THE KINETICS OF HETEROGENEOUS EQUILIBRIUM, AND OF THE STRUCTURE OF LIQUIDS

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While Gibbs,[1] in his remarkable treatise "On the Equilibrium of Heterogeneous Substances" has given a very broad treatment of his subject from the thermodynamic standpoint, nothing is included which would give any idea of the probable distribution of a component between a set of phases from a knowledge of the properties of only the pure component and of those of the phases before any of this component has been added to them. It is the purpose of this paper to indicate that the general nature of such a distribution can be predicted in most cases from the standpoint of the hypothesis that it is determined mainly by the intensity and nature of the electromagnetic field surrounding the molecules, and by the motion of the molecules and atoms. There is considerable evidence that the atom consists of a positively charged nucleus surrounded by a system of negative electrons. On such a basis it is to be expected that the atom, and therefore the molecule, would be surrounded by an electrostatic field. Inasmuch as there is much evidence from the magnetic properties of substances that the electrons are in motion, this is also to be considered as a magnetic field. Such a composite field is usually said to be electromagnetic.[2]